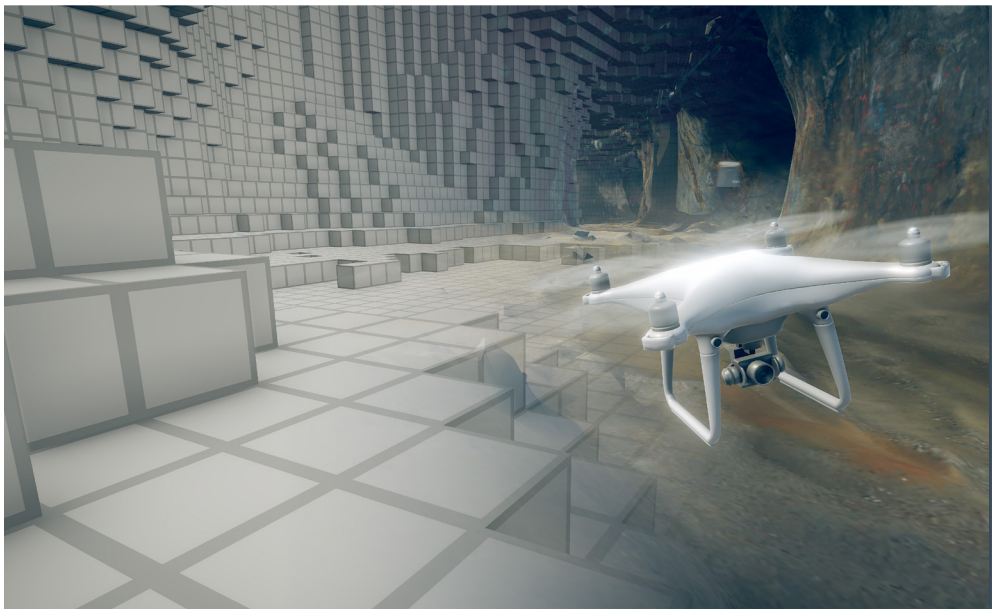
mining3

2019-20 ANNUAL REPORT



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About Mining3

Mining3 is a world-leading, member-based research organisation.

We are directed by our global mining industry members to research, develop, and deliver transformational technology to improve productivity, sustainability, and safety.

Our 'three pillar' vision for the mining industry focusses our activities on: Lean Mining, In-Place Mining, and Sustainability through Technology.

Leveraging our 29 years of industry experience, extensive networks, and foundation of knowledge, our researchers develop solutions to industry-identified challenges using fundamental and applied research.

Based on the premise that collaboration is the most powerful instrument of innovation, Mining3 and its members work together to identify key industry challenges, focussing our research into areas that deliver the highest return.

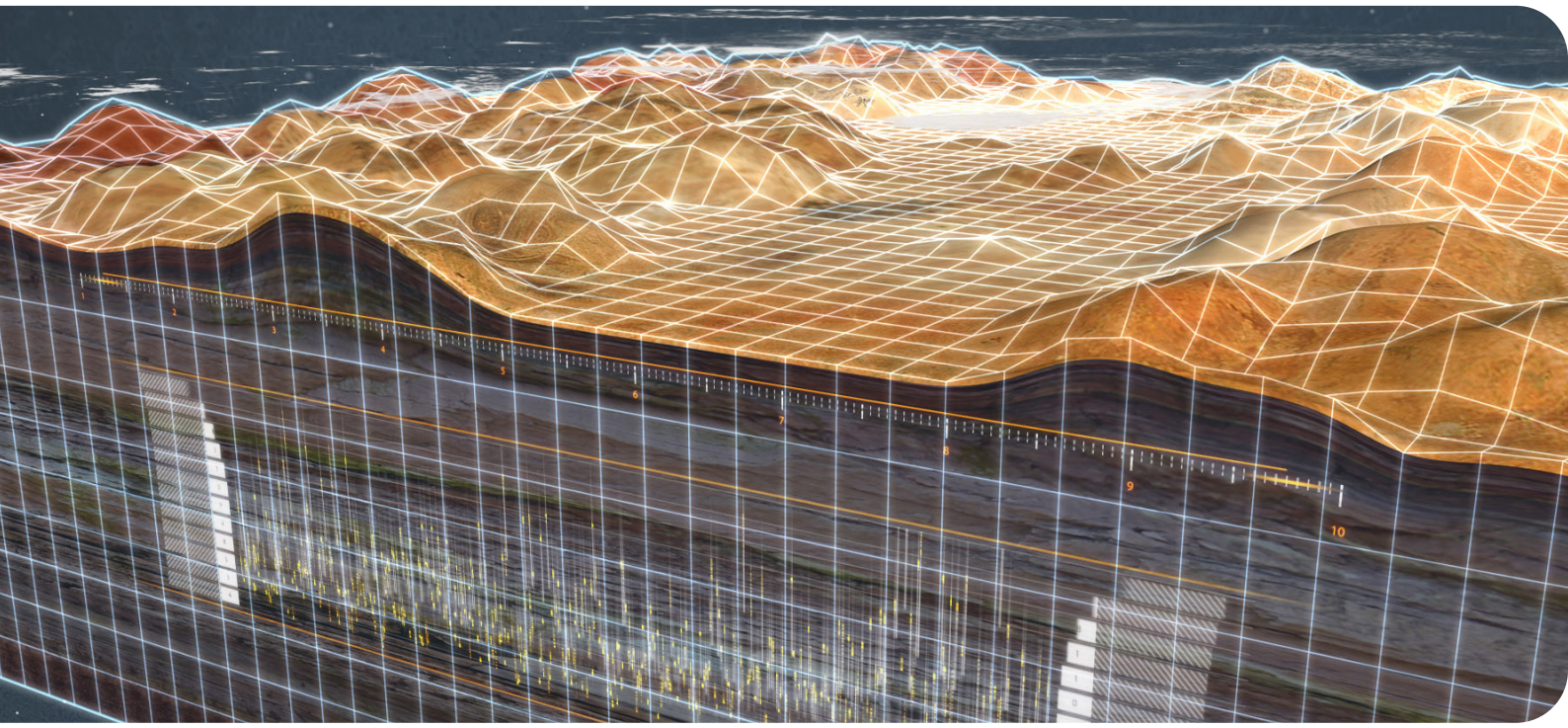
Mining3 membership is open to Mining Companies, Original Equipment Manufacturers (OEMs), Mining Equipment and Technology Services (METS) companies, and Universities.

Our membership provides a conduit into research and technology guided by an active cohort of thought leaders working to resolve the mining industry's biggest challenges.

By combining industry and research expertise, the delivery of solutions is accelerated, ensuring rapid and effective market availability—benefitting our members and the global mining industry.

Mining3 capabilities include but are not limited to:

In Place Mining • Energy • Green House Gas Reduction • Operating in Extreme Environments • Modelling • Mine Sustainability & Closure • Deposit Characterisation • Rock Breakage & Cutting • Geotech • Autonomous Systems • Interoperability • Bulk Handling Systems • Robotic Maintenance • Reliability • Safety



Established in 1991 and based in Brisbane, Australia, Mining3 has developed ground-breaking innovations that have significantly improved industry profitability, productivity and safety. Mining3 is flexible and responsive to the changing needs of industry priorities and works to deliver real-world solutions for the mining industry's most significant challenges. Our solutions speak for themselves: new and modified mining methods and processes, cutting-edge mining equipment, high-level operational control of the mining chain, and highly skilled experts. We strive to position our members for success, from solving key technical challenges to exploring and publishing thought-leading information necessary to drive industry change.

Our Vision

Our Culture

As a creative research organisation, we foster innovation, education and collaboration.

Our culture is underpinned by:

- *Our people being our greatest strength*
- *Strong and lasting relationships*
- *Leadership in its knowledge and expertise*
- *Continuously driving value by successfully responding to changing member industry needs*
- *Utilisation of robust research methodologies in providing leading industry solutions*

Our Vision

To transform mining globally through collaborative and innovative industry-driven research and technology.

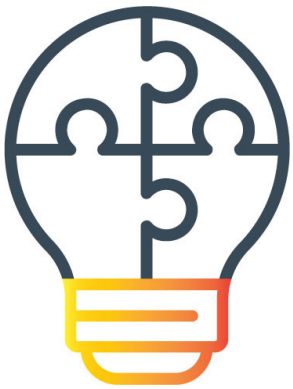
Our Mission

To deliver transformational innovation to existing, planned and future mines that maximise productivity, and or enhance resource utilisation, safety and sustainability.

Our Values

Drive innovation

We are driven to constantly challenge, question and improve the way things are done

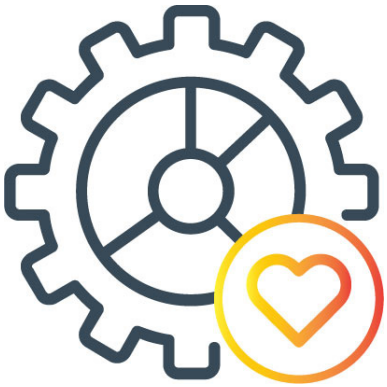


Invest in strategic partnerships

We openly collaborate with external partners, leveraging one another's strengths, knowing that we can achieve more together than separately

Demonstrate expertise, excellence and rigour

Our team thrives on new challenges and exceeds expectations in all aspects of work



Work with passion

We are enthusiastic and passionate about the work we do and how it contributes to the mining industry

Build collegial relationships

We openly collaborate and support, respect, and acknowledge each other, always

Sustainable business model

Our business continues to be commercially viable and responsive to industry needs while remaining environmentally and socially responsible

CEO's Report

It is my great pleasure to provide some brief remarks about the past fiscal year that cannot cover all the many and varied activities that have occurred throughout.

This past year for Mining3 has been one where we worked to consolidate a number of organisational changes that included a new structure and a focus on the health of our organisational culture. This included a collective effort to develop Mining3 values that define who we are, what we represent and how we engage with each other and the broader community. These are critical to making Mining3 a great place to work, achieve and grow. We are working hard to embed these values into our every day lives at Mining3.

The effect of these organisational changes and our focus on values delivered a very strong year. The Mining3 team worked effectively to deliver successful outcomes across a strong portfolio of projects for our members and industry partners. In addition, our focus on improving operational performance has been rewarded with an annual surplus of around $2.6M. This is a reflection of the significant effort and dedication shown across the whole Mining3 team. In particular, operational leadership from the Chief Operating Officer Susan Grandone, Research Leader Dr Ewan Sellers and Program Director Dr Erik Isokangas has been key to achieving this result.

In the second half of the year, Covid-19 presented a new and unprecedented situation. I would like to commend the Mining3 team for their flexibility and ingenuity in calmly and effectively developing solutions to work through these difficult times. For the final quarter of the year the team demonstrated the ability to produce real and applicable solutions directly to our members while working from their homes.

Over the past year we have seen strong engagement from industry for our research vision and roadmap which has resulted in a strong and growing project portfolio. Our partnerships with members (Mining Companies, OEM Suppliers, Universities / Research organisations) remain strong and are expanding. We have worked also to engage a broader cross section of the industry across the globe.

Of particular note, we had the pleasure of welcoming South32 and ENGIE as new members of Mining3. New members expose the membership and researchers to new ideas and problems while supporting different solutions. This has already led to valuable new projects with each of these new members.

On the commercialisation side, it is critical that Mining3 works effectively to bring our innovations to the market. The DAS conveyor monitoring technology, and our partner "the AVA Group" is an example of how Mining3 researchers and members of the AVA team have together. This was recognised at the 2020 Queensland Mining Awards where AVA and Mining3 were awarded the METS Ignited collaboration award. We continue to develop a strong pipeline of innovations, with a plan to bring several more to the market this coming year.

It was a great pleasure to welcome Leeanne Bond as the new board chair and I look forward to a long and fruitful partnership working closely with Leeanne. I would like to thank the Board for their support over the past year and in particular Brad Neilson for taking on the Deputy Chair role and working closely with me during the chair transition process. I would like to welcome the board members elected today.

In closing, we are in a solid and stable position and I believe the coming year will be another strong one for Mining3 that continues to deliver value to our members.

Paul Lever, CEO

Chair's Report

I am delighted to have joined your board and management team in March 2020 and feel very honoured to join such a great organisation.

Firstly, let me state that 2020 has been a very disrupted year for Mining3 due to the Covid-19 pandemic, as it has for everyone, and I am proud of the way your company has responded to the challenge. In a very short time, our people were asked to work remotely from home as our office was closed. Our projects were quickly restructured to maintain productivity by bringing forward the tasks that could continue while deferring laboratory work and travel until restrictions were eased. I'm pleased to say that the Pinjarra Hills offices and facilities are now fully operational again however travel will be affected for some time.

I look forward to meeting our members virtually at this AGM and plan to get to know you all better in 2021. Our membership has grown in 2020 as we welcomed South32 and ENGIE as new Mining3 members. We are already working on projects connected with these members including a intercontinental hydrogen initiative.

Whilst my recruitment and due diligence process was virtual, I'm fortunate that I had already met our CEO, Professor Paul Lever, in person. I have now been able to invest time in meeting with our executives in Pinjarra Hills as I also live and work in Brisbane but I am still yet to meet most of our board members in person as they are based interstate and overseas and have been unable to enter Queensland until recently. Our board meetings have been held by videoconference this year however we plan a face-to-face strategy day early in 2021 as soon as it is practical for those who can travel.

I thank all my fellow board members for their warm welcome to me and I would also like to acknowledge the board members who retired prior to my arrival - our former Chair, Theresa Mlikota, and retiring board members Professor Michael Bruenig and Andrew Ransley and to welcome Professor Neville Plint and Jim Callahan in their place (from UQ and CAT respectively). In particular, I would like to thank our committee chairs Brad Neilson (who acted as deputy chair during the transition) and Tony Sprague who have both helped me enormously during this period.

Mining3 continues to develop our strategic partnership with CSIRO which is operating very effectively and to the benefit of both Mining3 and CSIRO. Whilst there is still more to do to capitalize on the unique opportunity of this partnership in 2021, the operations are being very effectively managed by Chief Operating Officer Susan Grandone and Research Leader Ewan Sellers under the executive sponsorship of Paul Lever and Jonathan Law.

Our key relationship with The University of Queensland is also developing further. We welcomed Professor Neville Plint to the board after his election by Research participants in November 2019 and he has been very helpful in identifying research opportunities and supporting our tenure at the Pinjarra Hills site. His role as Director of the Sustainable Minerals Institute at UQ bring strategic insight and alignment with UQ, while we manage any real or perceived conflicts of this role with his role as a director of Mining3.

Mining3 is now well positioned to focus on its core business and is also well positioned from a cash and balance sheet perspective. You will see in the attached financial report that it has been a great year. Total income has increased to $12.4M, particularly from industry funded research (including Caving 2040) and grants as well as royalties from the Cave Tracker beacon. Management expenses decreased by 10% during the year reflecting more efficient operations with over 85% of expenditure on research. Total equity is $9.8M and current assets exceed current liabilities by $8M so we are financially strong enough to weather the current conditions. I believe 2021 will also be a good year for Mining3 – we have the ability to build on a solid foundation to deliver even more value to our members.

And finally, thank you to our members and partners for your ongoing support and investment. Thank for your support of Mining3 and myself as incoming Chair in 2020.

LKBond

Leeanne Bond, Chairman of the Board

2019-20 A Review

August 2019

Launch of Aura IQ set to revolutionise conveyor health monitoring. Conventional methods of advanced conveyor failure detection is often unreliable, subjective, time-consuming and labour intensive. The Aura IQ uses real-time data to optimise production and on-site performance, enhance occupational health, hygiene and safety management, and introduce exciting new predictive maintenance and support capabilities to asset management. Having successfully completed surface and sub-surface testing with some of the world's largest mining houses and bulk material handling facilities, Aura IQ is now available for sale globally.

August 2019

Mining3 **finalists for Austmine METS Innovation Award**. The Mining3 Distributed Acoustic Sensing (DAS) for conveyor monitoring team received a finalist position in the Austmine 2019 METS Innovation Award. The application process was extremely competitive and the six finalists represented the highest calibre of mining research globally.

September 2019

Mining3 farewells Theresa Mlikota. After four years of direction and leadership on the CMTE Dev Ltd Board (trading as Mining3), one of our loyal Directors and Chair Theresa Mlikota announced her plan to leave the Mining3 board. During her tenure on the Mining3 Board she has participated in the transformation from a commonwealth funded CRC to a fully industry funded organisation. Theresa guided our partnership with CSIRO, focused our efforts in the commercialisation of transformational technologies, and promoted our expansion internationally.

September 2019

Gideon Chitombo joins the ranks of Mining3. With over 20 years experience as a Professor, most recently as the Chair of Minerals Engagement at The University of Queensland's Sustainable Minerals Institute, Professor Gideon Chitombo is now working with Mining3 as a Technology Leader specialising in Cave Mining.

December 2019

Updates to the Mining3 Board. With his recent appointment of Head of School for the School of Business, Michael Bruenig has had to step down from the Mining3 Board. Neville Plint from the University of Queensland elected by the Research participants as his replacement. Secondly, after eight years with a seat on the board Andrew Ransley is retiring from Caterpillar and the Mining3 board. For the coming year, fellow Caterpillar General Manager, Jim Callahan, replaced Andrew.

December 2019

Breakthrough for Alternative explosives. Mining3 achieved a significant milestone with the successful detonation of a world first* hydrogen peroxide-based emulsion explosive. Using proprietary formulations, a series of trial blasts, confirmed its ability to detonate, and provided early steps into the characterisation of this improved product. The new formulation is a major achievement in superseding water-gel/hydrogel formulations and a crucial advancement in product stability and sleep-time.

March 2020

Mining3 welcomes new member South32. South32 is a globally diversified mining and metals company. Mining3 CEO, Professor Paul Lever, welcomed the new member, stating, "South32 is a well-respected organisation with a diverse portfolio with the opportunity to engage in a number of meaningful projects into the future. We're very much looking forward to working more closely with their team".

March 2020

COVID-19 Novel Coronavirus and Mining3. As of March 23rd, Mining3 implemented a work from home approach for all staff capable of working effectively on desktop solutions remotely. Our offices remained open for staff whose projects need to access specialised laboratories or equipment. We continued to operate this way until mandated otherwise by the state or federal government, further instructions from a research partner, or we deem the situation warrants.

April 2020

Mining3 welcomes new chair, Leeanne Bond. With over 30 years corporate experience including 16+ years as a professional company director and board member. Leeanne is a prominent engineering leader, advocating for improved project governance, innovation and entrepreneurship, gender equity and workplace diversity and inclusion. Leeanne was a founding executive of WorleyParsons' business in Queensland, NT and PNG.

April 2020

A national consortium led by The University of Queensland and University of Western Australia has secured $30 million from the Federal Government to help regional communities transition to a sustainable future after their local mines have closed. The consortium will form a **Cooperative Research Centre on Transformations in Mining Economies (CRC-TiME)** with hubs in both Queensland and Western Australia. Mining3 is one of the largest contributors.

July 2020

Mining3 launches an **online sensor technology capability toolkit** providing users with unbiased information on Proximity Detection System sensors to assist in their decision making process. The PDS Toolkit is part of the Mining3 ACARP funded project titled "PDS Validation Framework – Phase 3". The easy-to-use interface provides a high-level summary of the six most prevalent Proximity Detection System (PDS) sensors available to the market.

July 2020

ENGIE Joins Mining3 to Accelerate Mining Industry Decarbonization by Co-Creating Hydrogen Solutions. "Mining3 has already identified a number of projects that align with both ENGIE's strategy as well as the mining industry's current and future needs. We believe that these only scrape the surface of what can be done in this space, and are looking forward to developing a diverse and forward-thinking energy roadmap for our members," stated Mining3 CEO, Paul Lever.

Our Research

Mining3 works with its members to provide research and technology to solve industry identified challenges.

- Members decide what research is undertaken
- Industry committees test and challenge all research initiatives
- Collaboration filters out ineffective use of research resources/funding
- Focus on the right problems and best opportunities

For the mining industry to operate profitably and sustainably in the future, it must transform across several fronts. The Mining3 strategic research vision for this transformation is focused on three key pillars as shown below in Figure 1.

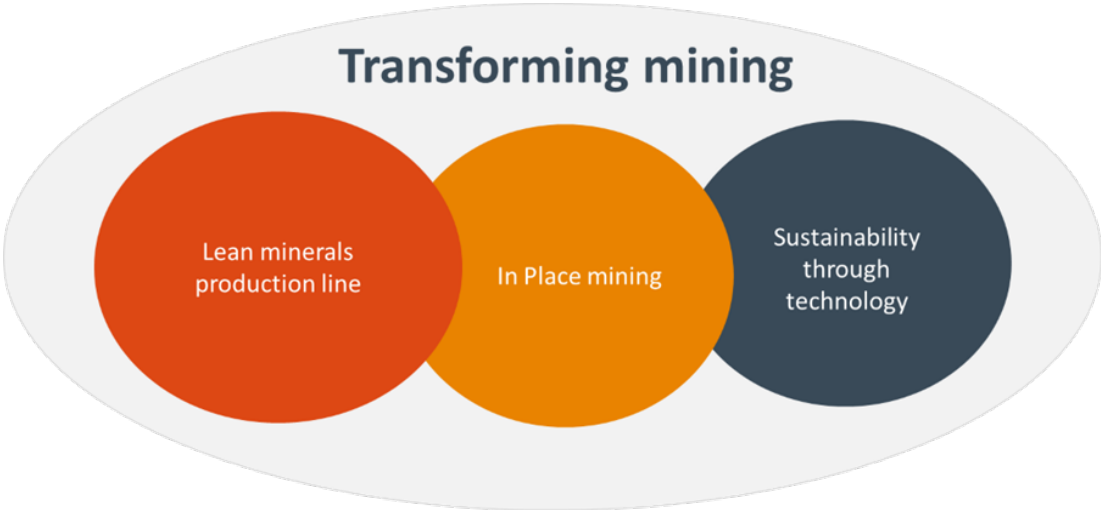


Figure 1: Strategic Research Vision for Mining3

THE LEAN MINERALS PRODUCTION LINE PILLAR refers to our focus on precision mining and bringing control as close to the face as possible. As mining processes evolve, we've discovered that the sooner we identify the value of the ore, the higher the return on investment. This pillar underpins the requirements for mining methods and processes to be precise and controlled and mining systems to deliver to their design specifications. For current mining operation this means applying measurement and control strategies to drive optimal operation performance (rated performance), often through continuous improvement approaches. This applies across the full mining value chain.

Approaches used by this pillar include:

- Control and optimisation of the mining value chain
- Complete connectivity
- Delivering the right information at the right time and location
- Integrated automation
- Sensors and data analytics for dynamic mine control
- Interoperability
- New measurement systems

Figure 2: In Place mining research pillar

THE IN PLACE MINING PILLAR drives the need for radical approaches that deliver new thinking about how mining happens. This means the development of new fundamental mining methods and processes that encapsulate the characteristics of both the "Lean minerals production line" and the absolute requirements proposed by the "Sustainability through Technology" pillar. The In Place mining approach proposes new thinking about mining through three sub techniques (see figure 2 above).

All these encompass the following characteristics:

- Significantly reduce surface footprint
- Reduced mine transportation infrastructure – waste material remains in the mine
- Smaller processing plant size due to high grade feed and processing in place
- Significant reduction in tailings dam footprint
- Modular production units with the ability to scale and reduce as required
- Reduced energy need

All these approaches attempt to adhere to the primary concept of designing a tight coupling between Discovery – Mining – Processing.

THE SUSTAINABILITY THROUGH TECHNOLOGY PILLAR looks to transform mining by placing sustainability (economic, environment and social) requirements at the heart of the mine planning process and developing significant new technology innovations and operational designs to accomplish this.

The following are sustainability issues that must be addressed.

- Right to mine
- Social - positive, clear and transparent engagement with community
- Energy, water, materials and waste use – reduction and recycling'
- Removal of people – potential high level of automation
- Small footprint mining
- Adopting a lifecycle approach – integrating community benefit, supply chains and performance criteria

Project List

Active projects during 2019-20

Mining3 is a world class research institute focussed on delivering transformative solutions to the mining industry. We do this through a combination of industry, government and self-funded (Mining3 funded – Seed funded) projects in line with our strategic research roadmap. Each project, however small contributes to a larger picture of how we and our members envision mining in the future. Note: fully confidential projects are not listed or described here but governance is still through Mining3's technical committees and research committee.

A baseline dataset for performance evaluation of visual detection and classification techniques in mining environments

Advance the understanding and development of techniques that can detect and recognise objects in the mining environment in particular people and vehicles. The objective is to build a dataset which will be open to all members. This will enable us to test if the technology is ready.

Automation TC, Program 5

ACARP C26032 – Autonomous sensors for evaluation of groundwater pressures in spoil dumps and tailings – Phase 2

The main objective of this project was to develop a wireless sensor solution that will determine the groundwater pressure and flow throughout a spoil dump or tailings dam.

It is proposed this solution will monitor the condition of the spoil dump or tailings dam internally and autonomously.

- A sensor network inside the spoil dump or tailing dam will gather data on the internal structure and relay that information to the surface for evaluation and prediction analysis.
- The sensor network will communicate wirelessly to each other using the best determined method such as RF or Magnetic Induction.
- Creating an adhoc network capable of transmitting sensor data wirelessly to a surface receiver. The surface receiver would then transmit this data to a central database
- The sensor will contain multiple electronic measurement sensors that will obtain the physical measurements of the surrounding environment
- Internal battery will power the system for the required duration (10+ years)

Surface TC, Program 3

ACARP C28019 – Carbolt - Self Monitored, Yieldable Carbon Fibre Cable Bolt for Ground Control

Roof support systems for mining applications are typically manufactured from high-tensile steel and, in some circumstances, from fibreglass composite materials. However, materials with much higher tensile load capacities are now available and there is an opportunity to apply this technology in the mining industry. This project seeks to develop the next generation of advanced rock support. A 'coilable', Carbone-fibre based, instrumented rock bolt prototype will be designed and laboratory tested.

The rope will be able to be manufactured in pieces of predetermined length or in bulk and be rolled onto a drum for deployment into a drill hole by a 'to-be designated' machine before being cut to length as needed during installation.

Underground TC, Program 4

ACARP C26035 – DynaCut™ Fundamental Development, Surface Mining - Phase 2

This project phase follows directly from the current ACARP Project C25041 - Dynacut fundamental development and capability testing for high capacity mining of coal overburden, which completed excavation trials at a sandstone quarry at Helidon, QLD. This was the first time that Dynacut has been tested in soft/medium/high-strength sandstone with purpose-built cutters in an in-situ environment. It produced encouraging cutting rates and demonstrated very low levels of cutter wear, indicating significant performance potential for application to overburden removal.

This current stage of work (Phase 2) aligns with the overarching strategy of core research and development to demonstrate the performance and scalability of the technology; to ultimately justify a commitment by Joy Global and/or Industry consortium to develop a full-scale prototype system.

The principle aim of Phase 2 is to establish key design criteria and develop an advanced design for an up-scaled test machine. This up-scaled machine will demonstrate the scalability of the Dynacut technology via site testing in a subsequent Phase 3. Phase 2 incorporates several specific elements, including further testing, to inform this up-scaled machine's requirements with regard to key aspects including power delivery, oscillating parameters, and cutter design.

Surface & Underground TC, Program 4

ACARP C26028 – Proximity Detection Systems (PDS) Validation Framework

Proximity detection systems (PDS) for mobile equipment, people, and other structures are increasingly being used to establish effective collision management strategies. However, there are so many proximity detection systems and multiple sensing technology categories that it is difficult to select the best PDS for specific applications. In this project researchers will conduct a critical review and assessment of PDS technology types, application, constraints, and implementation requirements; develop a testing methodology to verify and assess proximity detection systems; and produce a set of measureable, objective metrics to describe performance criteria. This project aims to align and build upon the EMESRT PR5A body of work to develop a set of standardized functional, performance, and technical specifications with an associated testing regime for validating PDS system capability relative to control levels 7, 8, and 9 in open-cut mining.

Underground TC, Program 3

ACARP C27034 – Top-of-Coal detection while drilling

Cease drilling at a suitable stand-off from the coal seam, accurately and consistently for each and every blast hole. Data collected during routine production drilling has the potential to be fed back to update and improve exploration data and optimise blast design.

Accurate control of overburden blasthole depth has the potential to significantly improve mine profitability through reduced coal loss and dilution. However, the current techniques for seam mapping from exploration holes do not provide an accurate surface profile at the local scale required for effective stand-off control. A novel approach using a geotechnical measurement technique has been developed to determine coal seam location while drilling in a rotary air blast (RAB) drill rig. In this project, incremental design changes are being made to the system, which will then be retrofitted onto a production RAB drill rig for further testing.

Surface TC, Program 3

ACARP C27024 – Blast performance evaluation of production scale trials using hydrogen peroxide-based hybrid explosives

To eliminate Nitrogen Oxide (NOx) fume emissions after blasting an alternative Hydrogen Peroxide (HP) and fuel based explosive has been developed.

The objective of this C27024 project is to demonstrate the manufacture and delivery of Hydrogen peroxide (H2O2)-based explosives using a specialized Mobile Manufacturing Unit (MMU) and evaluate blast performance in surface mine-site operations with increasing scales of production. To date, H2O2-based explosives technology has been limited to small scale quarry tests of a manufacture-and-immediate-detonation application. This project progresses the research plan for H2O2-based explosives from confirmation of first viable formulations meeting sleep-time and detonation performance towards implementation and adoption by focusing on manufacture and delivery procedures to meet mine-site operational requirements.

Surface TC, Program 3

ACARP C27075 – Advanced Pattern Recognition through Machine Learning for DAS Conveyor Condition Monitoring

The recent research in phase 2 as an extension of project C24014 has revealed new insights into the way conveyor idler bearings wear, and how distributed acoustic sensing can be used to for early detection of the progression of bearing failures.

These new insights, and current research with straightforward rules-based methods suggest a more advanced approach is required to enable automatic recognition of bearing failure. This is due to the complexity in the failure patterns, the degree of noise, and the individual characteristics of any particular conveyor.

In the longer term, the machine-learning methods researched under this project can be adapted to a wider range of coal mining applications which may include detecting chute lining wear, or diverse machinery in longwalls such as miners, armoured face conveyors and continuous miners. Automated pattern recognition via machine learning would be applicable, also, to large-scale data analysis (big data) for mining.

Surface TC, Program 3

ACARP C27023– Enhancing the sleep time of Hydrogen Peroxide based explosives

To eliminate Nitrogen Oxide (NOx) fume emissions after blasting an alternative Hydrogen Peroxide (HP) and fuel based explosive has been developed.

This project aims to quantify and improve the density stability and thus sleep-time of Hydrogen peroxide (H2O2)/fuel-based explosives technologies by further investigating the use of phosphonates and chemical stabilisers; mechanical sensitisers; and emulsion manufacturing processes. The project will involve laboratory-based investigations, blasting range trials involving detonation performance and sleep-time tests on a mine site rock samples. The objectives of the research are to achieve a stable product that can be safely tested in the field during the follow on field trial project. With the improvement of sleep-time the H2O2/fuel-based explosives can be expanded beyond the manufacture-and-immediate-detonation application.

Surface TC, Program 3

Automated Inspection of Mobile Machinery through Remote Optoelectronic Imaging and Point Sensing

This project seeks to address the identified problem around condition monitoring and maintenance practices of mobile machinery. This project aims to satisfy the Mining3 strategic initiative of “reliability, maintenance, safety and support systems.

The goal of this project is to provide technologies that would increase the availability of mobile equipment from a maintenance perspective. The vision is to deliver a product that would automate the maintenance troubleshooting process, through hard or easy to reach components without touching it. This technology would initially be used in a workshop but rapidly be extended to a stationary vehicle near the pit and eventually while operating under load.

Automation TC, Program 3

Borehole Temperature Sensing Phase 1 & 2– Industry Funded

Remote borehole preblasting sensor system that can provide real-time feedback on rockmass characteristics, such as temperature, to aid in the risk mitigation process during blasting activities.

Underground TC, Program 3

CRC ORE P2-005 – Grade Engineering process Simulation Modelling

This project was to develop a valuable framework of methods and models that the industry can use to simulate, validate, and optimise proposed Grade Engineering (GE) solutions for their operations.

The framework enables mining and METS companies to incorporate the GE methodology into their existing simulation systems through unique deliverables such as:

- A method to incorporate GE processes, such as grade-by-size block models with uncertainty modelling, into discrete event, time-based simulation systems
- Discrete event equipment and process models that employ GE control levers, reliability, and time-usage functions.

An interface to IES to provide a feedback mechanism to inform and control mining process models based on total value metrics. A method for IES-integrated scenario planning; simulating thousands of variations in time-dependent mining parameters to identify the best opportunities to maximise value of the GE solution

Surface TC, Program 4

CRC ORE P2-007 – Custom Blast Design Value Proposition

Work is required to identify the value proposition of the ABDO GE Blast Optimisation Tool developed in P2-002. The project developed an optimizer for determining the best regular blast pattern and hole charges for a given block with a fine resolution spatial distribution of blastability and grade distribution. Concurrently with P2-002, Mining3 have also developed the Genetic Algorithms Pattern Segmentation (GAPS) optimisation tool to identify the possibility for segmenting the mine into blast patterns with similar design parameters. Studies of the value optimization process indicate that the results are sensitive to the spatial distribution of grade and blastability and the relative costs of mining operations.

Surface TC, Program 4

CRC ORE P2-009 – Elastic Limit Blasting to Maximise Grade Engineering

Use numerical simulations to identify zones where differential stresses or strains would induce gangue liberation. The objectives of the project are to use numerical simulations to identify zones where differential stresses or strains would induce gangue liberation in coarse sizes. The theories of composite materials and shock wave propagation in heterogeneous materials developed in solid mechanics and materials engineering may be adopted and modified to address the strain limit blasting in this project.

The main question that should be investigated is that "Would it be possible to preferably control and optimise the blasting to fragment the soft ore materials to fine particles and not to break the harder gangue minerals?" If yes, then sieve/screen-based approach may be used to separate the fine ores from the coarse waste, based on Grade Engineering theories.

If this project is successful in identifying an opportunity to influence natural deportment by applying selective fragmentation to a synthetic blast design, then a potential second project would consider how the relevant rock mass parameters can be measured in the field, and a new selective fragmentation blast design workflow would be developed

Surface TC, Program 4

CRC ORE P2-008 – Heterogeneity Index for Ore Mixing

This project aims to address this challenge by developing a proof-of-concept for a probabilistic methodology for transporting ore property information through the extraction and handling stages of minerals production aiming to preserve the in-situ ore heterogeneity profile and thus reduce ore loss. Based in statistical physics, the framework predicts the mixing and segregation of ore as it would be extracted and hauled via different scenarios, thus enable tracking of ore and ore property evolution.

Surface TC, Program 4

CRC ORE P2-010 – Valorisation of Grade engineering by-products

This project seeks to both identify methodologies within the scope of short term mine planning to minimize the costs associated with early waste rejection and to identify opportunities within the scope of long term mine planning to make best or beneficial use of additional coarse rock, called Grade Engineering by-product material. Combined, this will facilitate a systematic approach to developing an optimized waste management strategy with a clear pathway to maximize value gained from Grade Engineering.

The objectives of the project are to study and characterise GE by-products, assess the alternative application of GE by-products, study socio-environment impacts of GE, and provide inputs and strategies for the evaluation of GE stream impacts on waste associated cost profile within the scope of short term mine planning.

Surface TC, Program 4

CRC ORE P2-011 – Variable particle size separator

Grade Engineering creates an opportunity to unlock additional value in ROM production by utilizing early stage separation of gangue from ore. Separation based on particle size using screens is already an established technique. The value-add of a size-based separation technique could potentially be significantly enhanced with the ability to alter the mass pull by dynamic manipulation of the cutoff particle size.

Surface TC, Program 4

CRC ORE P2-013 DAS for vertical spindle crushing machine control

Research to determine if acoustic measurements can be used for the control of the new generation of vertical spindle crushing machines.

Surface TC, Program 3

CRC-P Kapundar Copper In Situ Recovery (ISR) Project – Mining3 Seed, University, Industry and Commonwealth Gov funded

Working with ISR mining specialists, Environmental Copper Recovery, on a Commonwealth Government CRC-P (Cooperative Research Centre) grant which funds a 2.5-year research program to better understand and resolve key ISR mining challenges— particularly in relation to environmental, social and economic impacts.

Surface TC, Program 4

Distributed Acoutstic Sensing (DAS) for Identifying Geological Features in Rock Mass

The ability to provide an accurate model of the rock mass ahead of extraction has many economic advantages. Being able to optimise the direction of drilling and blasting with a detailed and high resolution ore body model would greatly impact the daily output's value. Furthermore, a high resolution model would greatly impact short and long term planning for the operation, as well as improving confidence in resources and reserves. Mining3's success with distributed acoustic sensing (DAS) using fibre optic cable is opening new opportunities, with the possibility of exploring its application to micro- seismology.

Surface TC, Program 3

Electric Haulage Value Modelling - phase 1 – Industry and Mining3 Seed funding

Phase 1 of this project aims to determine the impact of replacing current manned diesel fleets, with various scenarios involving manually-operated or autonomous electric trucks with different payload capacities for the selected mining operation. Mining3 has been actively researching electric

haulage systems, working on case studies such as satellite and open pits. We also have experience in evaluating IPCC and trolley-assist solutions. Through this process, Mining3 has developed methods and tools for modelling, simulating, and assessing the impact of new technologies on mining processes.

Energy & Sustainability TC, Program 3

Fibre optic monitoring for ground control – Mining3 Seed funded

The geotechnical conditions that exist in the rock mass, together with the influence of mining activity, should be well understood in order to be able to predict or assess the ground conditions with any degree of reliability. This project seeks to address the problem and to satisfy the Mining3 strategic initiatives of enhancing engineering best practice for ground control and safety through embedding novel fibre optic sensing technologies in the geotechnical engineering toolset. The fibre optic monitoring will initially supplement and in some cases entirely replace existing conventional systems for (a) displacement and convergence monitoring, (b) absolute stress measurement and stress change monitoring and (c) seismic monitoring.

Underground TC, Program 4

In Mine recovery for stranded ore deposits – Mining3 Seed funded

SEED project to develop a value case surrounding the use of In Mine recovery techniques for stranded or late stage ore deposits.

Surface TC, Program 4

In Line Mining Technologies – Mining3 Seed Funded

SEED project to discover new ways to link sensing, cutting and processing in a future mining environment.

Surface TC, Program 4

Microbial carbonate precipitation dust suppression

The overall aim of the Project is to develop a novel dust suppressant technology based on microbial carbonate precipitation for AngloGold Ashanti's tailings storage facilities in South Africa. This technology may also improve geotechnical stability and reduce trace element mobility.

Surface TC, Program 1

MRIWA M0487 – Actuated Undercutting Disc – Mining3 Seed and Industry Funded

The overarching objective of this project is to make mechanised fragmentation a viable method for breakage and extraction of minerals in hard rock mining. Focusing on Actuated Undercutting Discs technologies, the project sets to achieve this goal through understanding and optimising rock breakage mechanism, and lessening the energy required for rock fracture. Investigating the mechanics of cutter/rock interaction, associated rock failure mechanism and the role of the controlling parameters, the project provides strategies to enhance the effectiveness and efficiency of the mechanised breakage method, developing controlled and stable excavation technologies. This means controlling the mode of rock failure and the extent of the rock being removed to regulate and constrain the reaction forces within the limits of the machine power, while maintaining optimum performance. Ultimately, the research outcome facilitates development of potent and energy efficient tools by preventing the energy loss in processes that are not required, opening new avenues for design and optimisation of hard rock technologies. The project received co-funding from MRIWA as of May 2017.

Underground TC, Program 4

MWIRA M0499 – Establishing the in-situ rock bolt behaviour underground in order to model and design improved rock bolt support systems – Mining3 Seed funded

This project is concerned with developing an instrumentation technology to understand the combined loading conditions to rock bolts, caused by axial, shear and bending loads. All of which, occur to rock bolts in-situ. The unique feature of this instrumentation technology would be three sets of diametrically opposed slots, with each set at one-hundred and twenty degrees and could effectively measure the shear and bending direction relative to the cross-section of the rock bolt. This is unlike previous instruments where the shear direction could only be estimated in one direction as a single set of diametrically opposite slots were used. Two promising strain measuring technologies, which use optical fibers (Fiber Bragg Grating and Distributed Optical Sensing), have already been successfully implemented in a limited trial by the Applicant. Laboratory trials have been completed and 10 bolts were installed underground in a hard rock mine in Western Australia. A second and third trial will demonstrate the technology in a coal mine and second hard rock mine respectively. Results currently look excellent.

Underground TC, Program 4

MRIWA M0519 – In Situ Recovery (ISR) of Value from Mineral Deposits - Mining3 Seed funded

Consider the key technical challenges related to the measurement, creation, improvement and sustainability of target mineral liberation and access in an in-situ mineral system, and the design, introduction and control of new and improved lixiviants for more efficient and selective extraction of values with a reduced environmental risk.

Underground TC, Program 4

MRIWA M0522 – Physics Models for Ore Tracking – Industry funded

Develop the physics of material tracking in parts of the mining value chain where physical processes change the material shape and hence obscure the original grade distribution. The main areas of complex material movement and potential mixing include Blast movement, Digging, Dozer push, Truck loading, Truck dumping, Stockpile stacking and depletion, Surge piles and feeders.

Surface TC, Program 4

Measure While Drilling (MWD) – Industry funded

Evaluate MWD systems on the reverse circulation (RC) drill rigs and apply the data to improve blasting processes on site. Data collected by RC frills at mine site A can be used to inform blast designs to improve fragmentation outcomes and plant performance predictability.

Surface TC, Program 4

Mining development at great depth – Industry funded

This research will test an excavation damage hypothesis used to develop a global methodology for safe (and most economical) development construction at depths not yet reached by the current mining operations. This will enable the sustainability of underground mining even in conditions of very high stress, where failure can occur very soon after the construction of the underground openings.

The objectives of this work are to:

1. Collect and analyse relevant geotechnical data from mine sites,
2. Design an experimental fieldwork program utilising the proposed development solution,
3. Test the development design and construction methodology in a monitored field trial,
4. Analyse various sources of data to validate the design and construction method (eg. seismicity, deformation, rock mass damage)
5. Prepare final report of findings to submit to project sponsors.

Phase 1 completed the design, implementation and testing of this approach in a copper mine in Chile. Phase 2 further develops and undertakes further trials in Australia.

Underground TC, Program 1

Situational Awareness and Fleet Monitoring – SEED funded

The distributed acoustic sensing (DAS) and distributed temperature sensing (DTS) technologies are the main drivers behind the success of this project. The goal of this project is to develop a solution for complete situational awareness in an underground mining environment to optimise production and improve mine safety, and will be achieved through proactive maintenance practices, asset tracking, and improved vehicle to vehicle and vehicle to person interactions.

Underground TC, Program 3

Uncrushables – Industry funded

The Uncrushables Detection System technology aims to provide the capability to detect, in real time, tramp metals or "uncrushables" in a loader or shovel bucket (or LHD) such that these tramp metals can be isolated prior to the material entering a crushing or conveying circuit.

The project is currently completing large scale TRL 4/5 trials at several mine sites around the world. Current trial are focussed on wheel loader applications as this technology moves to the commercialisation phase.

The capability to detect, in real time, tramp metals or "uncrushables" in material payloads during digging or loading would provide significant benefits to mine operators through increased productivity, and reduced maintenance and repair costs. Primary crusher blockages can cause multiple days of down-time due to the difficult and high-risk task of clearing the material, particularly with up to several hundred tonnes of rock to be removed from the crusher to provide access. This technology would provide opportunity for original equipment manufacturers (OEMs) to incorporate these technologies as retrofit packages for existing systems and to integrate into machines for new product offerings.

Surface TC, Program 4

Underground Application of Alternative Explosives – Industry and Mining3 Seed funded

This project takes the previous MRIWA funded project outcomes and recent Hydrogen Peroxide explosive development work to conduct an underground field trial at a mine site. These explosives would potentially allow immediate re-entry after blasting.

Underground TC, Program 3

Initiatives & Collaborations

Adv Qld PTP grant: Enabling the Queensland Power System of the Future – Queensland Gov, Industry, Mining3, University of Queensland funded

Mining3 is working with the researchers in the AQ-PTP targeting reduced energy and carbon intensity focus on increased adoption of renewables in mining operations as well as increasing efficiency and reducing energy usage of mining equipment. Enabling a high penetration of renewable and other alternative energy sources with a focus on mining's unique energy needs requires knowledge based on modelling, simulating and emulating existing supply and augmentation systems as well as current state of the art renewable energy technologies and distributed generation.

Strategic business innovation leads to improved firm performance, productivity and growth. By focusing on enhancing innovation through strategy, mindset, structure and environment, the Research Centre will lead to improved performance of METS businesses and therefore higher productivity and sector growth.

Mining3 provides seed funding for this project and members can participate in their studies.

Cave Mining 2040 – Industry Funded

Cave Mining 2040 was developed as an international consortium that advocates for the collaboration to develop and accelerate innovations and new knowledge to ensure cave mining remains a technically viable, sustainable, safe and profitable business. The objective is to facilitate the development, validation and demonstration of new technologies and concepts through Horizon 1 projects each with its own scopes of work for the corresponding study areas to be identified, delineated and approved. It aims to engage stakeholders in supporting Cave Mining2040 collaboration and in particular projects leading to transformational technologies. The current six projects are:

2040 Project 1. Total deposit knowledge

An adequate level of orebody knowledge—including the total deposit knowledge (TDK), geological, geotechnical and hydrogeological characteristics—is the foundation upon which cave mining will be transformed in the future. The ultimate objective of TDK research is the ability to produce a 3D mining 'uncertainty' model of an ore deposit (that is, quantifying the key characteristics of the ore body not fully measured).

With the ability to transform geoscientific data collected during exploration into models of mining uncertainty, we can create a reliable system for the classification of minerals exploration results, and mineral resources and ore reserves according to the levels of confidence in geological knowledge within the technical and economic context. These levels of confidence will inform and guide subsequent cave mining-method selection, planning, design, construction, and operational decisions.

2040 Project 2. Cave Establishment

Reducing the high capital investment required to establish a caving mine requires a paradigm shift in how future deep ore deposits are accessed and caves are established. The cave establishment study area is focused on safety, speed, efficiency and reducing the up-front capital requirement.

2040 Project 3. Mine design for new and emerging technologies

By redesigning the extraction level arrangement to maximise ore recovery, we also enable the cost-effective use of emerging technologies and reduce the amount of required horizontal and vertical mining development, as well as ensure the effective and cost-effective implementation of automated production systems. Because the extraction level must remain in place for an extended production period, overall layout design, ground support and roadway conditions are critical factors. By initially investing in high-performing, large-scale, lasting infrastructure, the day-to-day operational costs can be lowered throughout the life of the cave.

2040 Project 4. High stresses and major seismicity

Effective management of increased stresses and seismicity due to deeper cave mines is a critical challenge, and the aim of this research area is to produce a benchmark dataset capturing current industry experience related to support of access and infrastructure in deep, high-stress caves.

The ability to predict subsidence is also critical for operational hazard and environmental impact assessment. Key geotechnical and mining parameters controlling ground support performance need to be identified and practical ground support design guidelines for operating caving mines developed. An outcome of this research will be validated design methodologies and interpretation tools for the advanced analysis of ground support performance.

2040 Project 5. Macro-block design and sequencing optimisation

The development of mining strategies for caving ore deposits with large footprints using the concept of macro-blocks has the potential to provide significant benefits. By taking into account in situ and induced rock-mass conditions and geological structures, while maintaining extraction level stability, macro blocks will potentially delay ingress of waste, as well as reduce up-front Capital expenditure.

2040 Project 6. Sublevel caving

Sublevel caving is a method often evaluated in parallel with block and/or panel caving options. It requires multiple levels of development and ongoing ring blasting for production. Sublevel caving allows for a more selective extraction but typically achieves lower production rates than block and panel caving methods.

By assessing and quantifying the interrelationship between blasting, fragmentation and gravity or disturbed flow that is available from purpose-conducted, full-scale studies we can determine methods for improving (primary) ore recovery. The research will extend or build upon ongoing work being carried out at Glencore's Ernest Henry sublevel caving mine in northwestern Queensland, Australia.

CRC TiME

A national consortium led by The University of Queensland and University of Western Australia has secured $30 million from the Federal Government to help regional communities transition to a sustainable future after their local mines have closed.

Centre for METS Business and Technology Innovation – Mining3, Qld government and University funded

The research centre has a METS focused research program aimed to build the capabilities of METS firms for strategic innovation and inform industry development initiatives delivered by industry associations and government organisations. The research centre will have a strong focus on industry engagement, communication and research impact pathways.

Interop - Improving interoperability across the mining industry

Chile's 'Technology Program for the Creation and Adoption of International Standards for Interoperability in Mining' was established in 2017 with the prime directive to create an international organisation (Interop) that facilitates the creation and revision of interoperability standards, in turn, producing a common language and guiding framework for the mining industry. Mining3 has participated heavily in the preliminary research surrounding the current state of play and recommendations for the future.

Recently completed projects

Contextual hazard detection - feasibility study

The aim was to develop machine learning techniques (based on deep learning) to automatically recognize hazardous situations on mine sites based not only on the recognizing objects in the scene but also on understanding the context in which that object is placed.

The project built on the expertise and world leading research in robotic vision currently undertaken by researchers at the Australian Centre for Robotic Vision within the Robotics and Autonomous Systems (RAS) group at Queensland University of Technology. Specifically, it builds upon promising work in the construction industry on contextual trip hazard detection, which should transfer well to the mining industry domain.

CRCORE P2-002 – Advanced blast design optimisation for maximising value through grade engineering levers – Industry Funded – Phase 1

The objective of this project is to initiate the development of a software module be able to easily design a blast pattern by using the 3D grade and response factor attributes to maximise the value to be derived though grade engineering levers appropriate to the given rock mass and mine. At the same time, the mining constraints need to be considered. The solution to this problem is to rephrase the blast design process as a constrained optimisation problem to maximise value by positioning the blast holes within the block under a series of operational constraints.

This project delivers a module that enables any Drill and Blast Engineer on site to create a Grade Engineering (GE) differential blast design with the optimal value identified via Integrated Extraction Simulator (IES).

CRC ORE In Situ Rock Mass Characterisation

To provide industry with superior approaches and systems for adequately characterising in-situ material to better inform blast design - thereby enabling optimal blasting outcomes for ore upgrading processes.

Development of a Proof of Concept Novel Transport System involving Small Autonomous Electric Wagons

The aim of this project was to investigate new ideas for the transportation of material in mining operations. It involved:

- Identifying, analysing, and ranking new and novel methods, in comparison to conventional truck haulage and conveying systems
- Developing and designing conceptual novel transportation systems, considering the application in mining, system design, mechanical, electrical, and automation requirements
- Modelling the applications and potential value and costs of the new concept(s)
- Designing and constructing proof-of-concept models
- Refining designs based on laboratory tests and outcomes from the above work
- Presenting the results to Mining3 members, seeking guidance on which approaches could be viable for the mining industry

Drill Hole Deviation Measurement – Industry funded

Mining3 have been collaborating with Robit to modify their new down hole measuring technology called S-SENSE for underground work. The system uses Mining3 patented direction-finding technology licensed to Robit. Unlike existing, time-consuming manual systems, measuring during the drilling process does not require an extra work phase in the drilling process. The measurements are available immediately after drilling a hole. The system is designed to measure the actual straightness of drill holes immediately after drilling the hole, so the information can be utilised in optimizing and charging a rock face.

This project is developing the underground version U-Sense that will be a directional survey tool for hammer drilling when circulating fluid is used. This phase completed the design and underground trials of the first-generation tool. We are working to complete the development of this tool.

MRIWA Development and Evaluation of Fume Free Explosives for Underground

This project takes the research to develop new bulk explosive products that can completely eliminate NOx fume emissions into underground applications.

MRIWA in collaboration with Northern Star, Barrick and Newcrest realised the potential and have funded early stage research with the aim to evaluate the application of this new explosive in underground mines and provide an opportunity to better understand, quantify and define benefits of HP-based explosive technology against conventional AN based products. To that end two phases of work were completed, including:

Phase 1 – Detonation performance characteristics in a controlled environment. This phase involves the evaluation of the detonation characteristics of HP-based products in a purpose built blasting chamber to quantify the evolution of gaseous sub products from detonation

Phase 2 – Implementation of instrumented trials at Sandvik's Underground mine testing facility in Finland in order to measure post blast fumes and compare breakage performance against a conventional product.

Pit Stability Assessment and Deep Orebody Characterisation – Microseismics – Industry funded

To design, install and collect microseismic data from small aperture geophone arrays that will be installed to monitor specific areas of the pit that are known to be hazardous. The resulting data is be processed to detect and locate source mechanisms associated with low frequency events which may or may not be associated with rock structures but will be associated with "movement" behind the rock face.

The objectives of this work were to:

1. To install a small aperture geophone network on the pit wall to continuously capture "creep" microseismic events and investigate the relationship between the weak events and slope displacement.
2. Use the network to capture any seismic event from deep below the pit and investigate the characteristics of the deep event for planning the next stage microseismic monitoring.
3. Use the network to capture production blasts and investigate feasibility of using seismic tomography to image deep rock mass that is yet to be mined

Robotic Manipulation for Automated Maintenance – Mining3 Seed Funded

Evaluate the feasibility of current state-of-the-art robotic manipulation solutions to be applied to the task of automated vehicle maintenance and make recommendations for tests, requirements and future capability developments.

Our People

Mining3 has a unique operating model. It consists of members from mining companies, OEMs (original equipment manufacturers) and Universities. Collaboratively, members identify the key challenges facing the mining industry and allocate funding to research areas which will deliver the highest return.

Our significant advantage over our competitors is as a result of our:

- Collaboration model with mining companies, mining services providers and researchers
- Scalability of operations globally
- Acceleration of innovation to market
- 29 years of experience in delivering new technologies
- Access to highly-skilled industry specialists and researchers

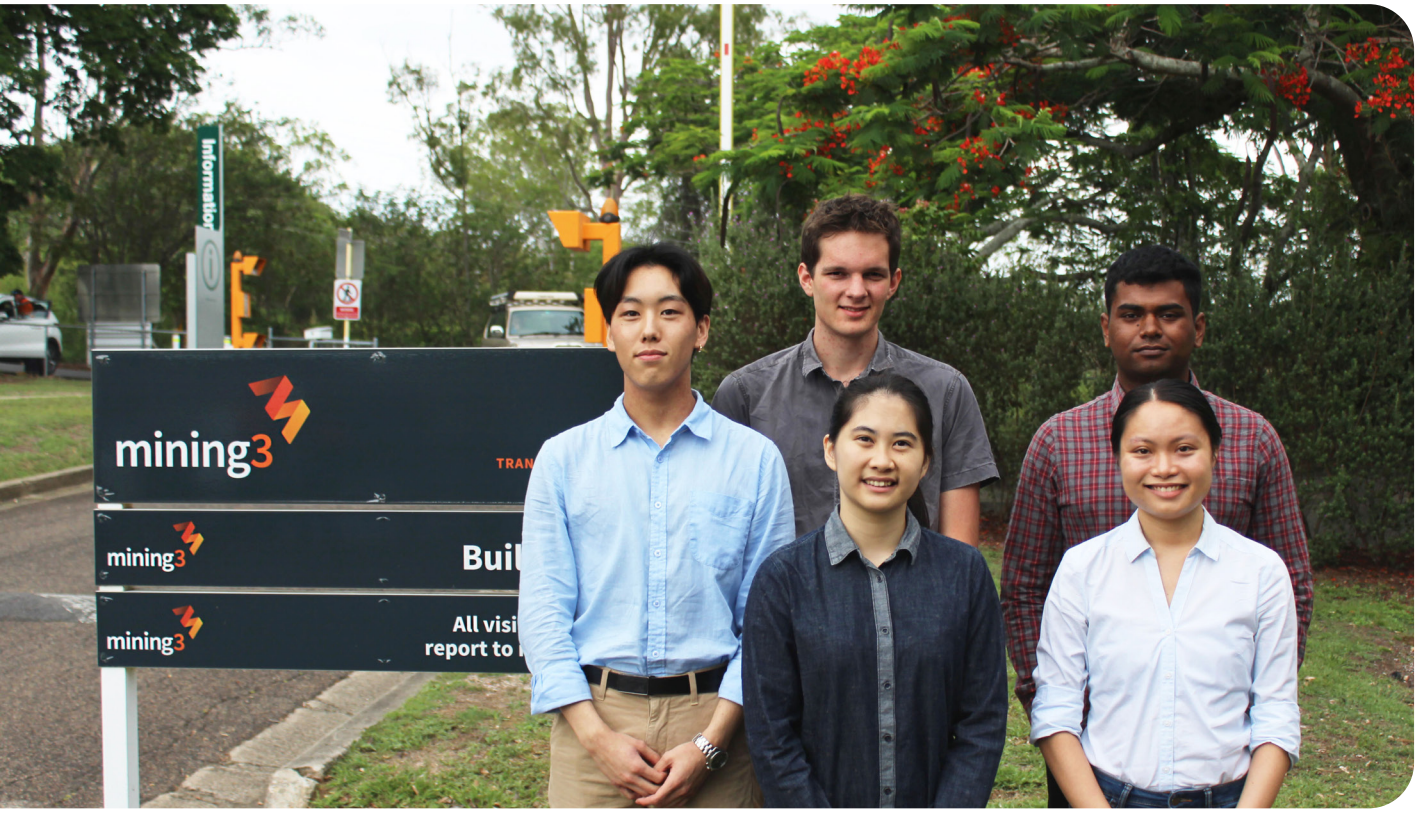
Mining3 Expertise

Our people are drawn from many fields and backgrounds, including university researchers, and leading experts in the mining and related technology manufacturing industries.

Our world-class researchers are highly experienced in understanding the needs of the Mining industry and collaborating with all the necessary stakeholders to achieve innovative and viable solutions.

Students at Mining3

Mining3 provides its research partners with a unique opportunity to engage with a large number of companies in the minerals industry to conduct collaborative high value and challenging research. It provides research opportunities and funding for a wide range of graduate students.



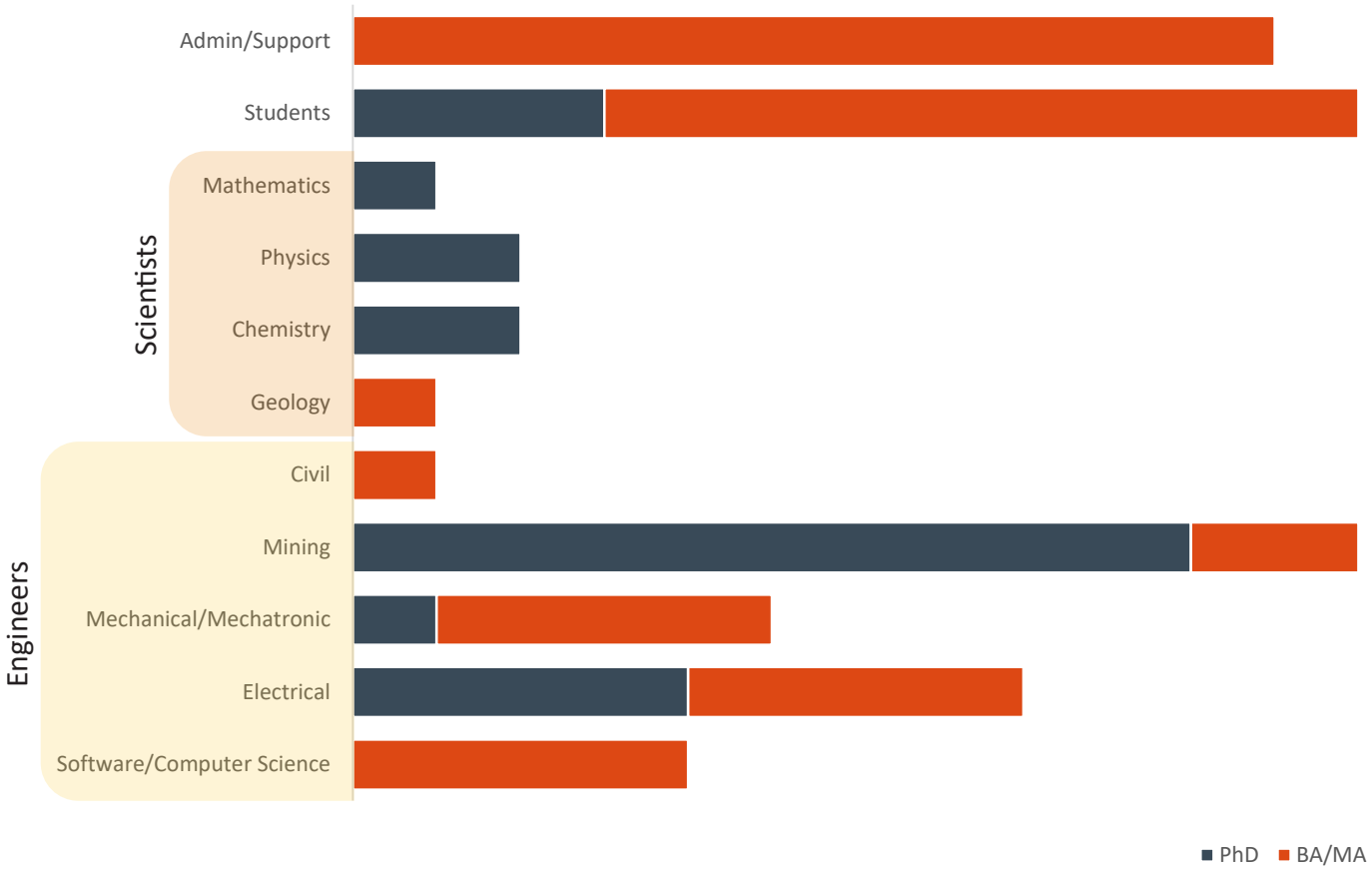


Figure 3: Skills and expertise at Mining3 2019-20

Our People

Executive Team

Mining3 is led by a strong leadership team with diverse backgrounds in research, technology transfer, financial, and legal expertise.

Prof Paul Lever
CEO

Susan Grandone
COO & Managing Director, Mining3 Canada

John Hood
Financial Manager

Dr Erik Isokangas
Program Director

Dr Ewan Sellers
Research Leader & CSIRO Research Director, Mineral Resources

Board of Directors

The Mining3 Board of Directors sets overall policy, determines the strategic direction and oversees technology transfer and commercialisation activities through quarterly meetings. In consultation with the Research Committee, the Board directs the research focus of Mining3.

Dr Leeanne Bond
Appointed Chairman of the Board
March 2020

Prof Paul Lever
Appointed to the Board May 2012
CEO - Mining3

John Lemon
Company Secretary
as of Jan 2019

Jim Callahan
Appointed to the Board Nov 2019
Director, Sales & Support - Caterpillar
Global Mining

Jonathan Law
Appointed to the Board Nov 2016
Director - CSIRO Mineral Resources

Brad Neilson
Appointed to the Board Oct 2015
President, Hard Rock Mining -
Komatsu Mining Corp. Group

Neville Plint
Appointed to the Board Nov 2019
Director of the Sustainable Minerals
Institute (SMI), UQ

Peter Salditt
Appointed to the Board Jan 2019
President, UG & Hard Rock Mining
- Komatsu Mining Corp

Luke Sandery
Appointed to the Board March 2019
Package Manager -
OZ Minerals

Tony Sprague
Appointed to the Board Jan 2019
Group Manager, Mining
Technology - Newcrest MIning

Our Members

Mining Companies

Original Equipment Manufacturers & Suppliers

Research Organisations

Becoming a Member

Members of Mining3 can commission or cooperate in independent or joint venture projects, allowing them to maximise the return from their investment, and achieve the reach and capabilities greater than any individual research effort.

Members can access researcher talent across multiple disciplines, Universities and Research organisations through Mining3 without the need to establish separate agreements with all the research partners.

Importantly, members can actively contribute in, and be the first to hear of, leading-edge and game-changing industry solutions.

"We're in it together to drive towards an innovative future"
Anglogold Ashanti – Graham Ehm

Value to members

- Reduced research risk
- Leveraged R&D investment
- Enhanced ability to target major mining challenges
- Access to world-class mining researchers, scientists and engineers
- Access to certain Mining3 IP
- Commercialisation and IP opportunities
- Participation in peer group meetings to identify key areas of focus

Membership process

- Membership period of 8 years (July 2014 through to June 2022)
- New members are welcome and the 8 year period will be extended accordingly
- Option to exit membership with 1 years notice
- Matching cash or in-kind contribution based on specified membership fee
- Members control long term research vision (20+ years) with a rolling 8 year research roadmap (roadmap revised every 2 years)
- Participation on Mining3 Research Committee, Technical Committees and Board

Partnering with Mining3

From time to time, Mining3 will partner with non-members on a specific research or commercialisation project. This arrangement falls out of the membership structure and is necessitated by a specific need of either the commissioning mining company or the required expertise to produce a commercialised product or technology.

Organisations Mining3 has partnered or collaborated with in the past include:

ACARP • Anglo American • Australian Research Council • AVA Group • Barminco • BHP Billiton • Codelco • CR Digital • CSC Australia • DSI • Elexon Electronics • Environmental Copper Recovery • ESCO Group LLC • Escondida • Glencore • MMG • MPS • MRIWA • Newmont • Northern Star • Peabody Energy • Rio Tinto • Roy Hill • Sandvik • The University of Newcastle • Theiss • Yakum Consulting

19/20 Financial Report

Total income increased from $11.2M in the prior year to $12.4M, with the most significant change being the income earned from Industry funded research and grants. Research staff (on average) exceeded the target industry funded utilisation rate of 60%, achieving an excellent overall result. Total income includes $475k of royalties received from the commercialisation of the Cave Tracker beacon.

Externally funded research revenue increased by 35% to $8.2M. This includes $1M from the Caving 2040 consortium projects.

The company recorded a surplus for the year of $2.6M, the first net profit in five years. Even after the removal of royalty income and our share of associated company profit, the operating profit is $1.7M. The positive effects of the structural changes made in 2018/19 are now fully realised.

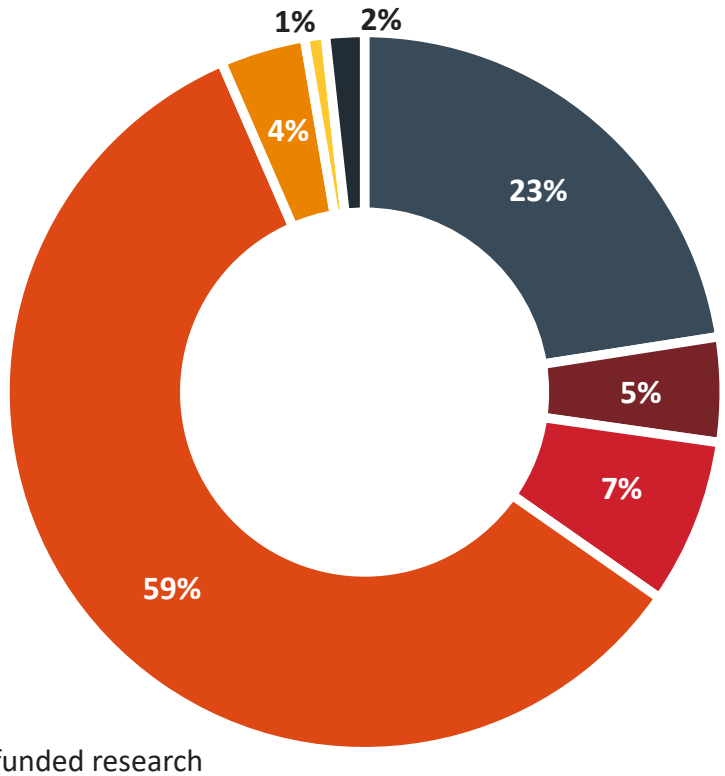
Total equity is $9.8M. Current assets exceed current liabilities by $8M. There is sufficient capital to meet the ongoing needs of the company and to safeguard against current macroeconomic events.

Participants' contributions represent the membership fees payable by both university and industry partners.

Other grants comprise competitively sourced funding directed to specific projects from the Australian Coal Industry's research program (ACARP), and the Minerals Research Institute of Western Australia program (MRIWA). Industry funded research revenue is primarily project work done for our members. Expenditure on research programs comprises 85% of all operating expenditure and represents both the direct and indirect (overhead) costs of conducting research.

Non-research costs comprise management expenses as well as the costs of technology transfer, business development and communications. Management expenses decreased by 10% during the year.

Total Income



- Participants' contributions
- Industry funded research
- CSIRO contribution
- Royalty income
- Other grants
- Interest received
- Other

Income Statement

	2019/20 $000's	2018/19 $000's
Income		
Participants' contributions	2,791	2,857
CSIRO contribution	585	555
Other grants	923	2,164
Industry funded research	7,282	3,897
Other revenue		
Royalty income	475	1,112
Interest received	116	163
Other	216	456
Total income	**12,388**	**11,204**
Expenditure		
Research programs	7,424	7,933
Research overheads	1,174	1083
Work, health & safety	80	81
Total research spend	8,678	9,097
Administration	702	959
Business development	298	250
Technology transfer	367	316
Communications	159	158
Operating expenses	10,204	10,780
Share of (profit) losses and write-downs in respect of associated companies	(447)	1,144
Surplus/(deficit)	2,631	(720)
Staffing (full time equivalents-FTEs):	FTE	FTE
Research	26	27
Administration	8.5	8.3
	34.5	35.3
Research spend per FTE ($000's)	286	294

Balance Sheet Summary

Net current assets (liabilities)	8,167	5,995
Total assets	14,876	12,141
Total equity	9,824	7,193

TRANSFORMINGMINING

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